CENTER FOR RESEARCH IN HUMAN MOVEMENT VARIABILITY

An Investigation into the Correlation Between Step Width Variability and Balance Deficits in Patients with Chronic Obstructive Pulmonary Disease

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INTRODUCTION

- Chronic obstructive pulmonary disease (COPD) is a pulmonary disease that causes dyspnea (i.e., breathlessness).
- Patients with COPD report muscle fatigue[1], decreased levels of physical activity[2], and balance problems[3,4]. They are also at a higher risk for falls that their healthy counterparts[5].
- Gait variability is defined as the side-to-side fluctuations while walking and is a useful predictor of future falls and diminished mobility[6]. Further, patients with COPD walk with a more repetitive step width pattern[6].
- However, a relationship between balance tests and gait variability has not been fully investigated. Therefore, it is unknown if balance measures and gait variability are related.
- Our purpose was to investigate how step width variability is related to balance deficits in patients with COPD.

METHODS

Group	N	Age (years)	Height (cm)	Weight (kg)
COPD	9	64.77(8.1)	64.77(8.1)	81.48(17.6)
Control	7	64(7.2)	166.17(9.5)	78.72(22.1)

Table 1. Means and standard deviations for the two groups.

- Subjects (Table 1) performed a series of balance measures: sensory organization test (SOT), motor control test (MCT), timed up and go (TUG) (Figures 1-2), Fullerton Advanced Balance scale (FAB); and subjective questionnaires: modified falls efficacy scale (mFES) and activities-specific balance confidence (ABC) scale.
- Step width was calculated from a six minute walk on treadmill (Figure 3). The standard deviation, coefficient of variation, and sample entropy of step width was calculated.
- Pearson product correlation coefficients were used to determine the level of association between the balance tests and step width variability.

Figure 1. The Neurocom Balance Manager System was used for the **SOT** and the **MCT**. The SOT assesses the three sensory systems that control balance (vision, somatosensory, and vestibular). The MCT examines the body's automatic response of correction of posture to a moving surface through a latency score.

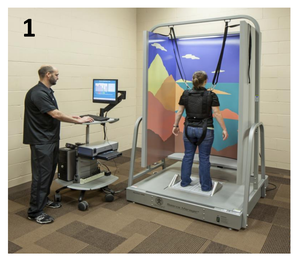
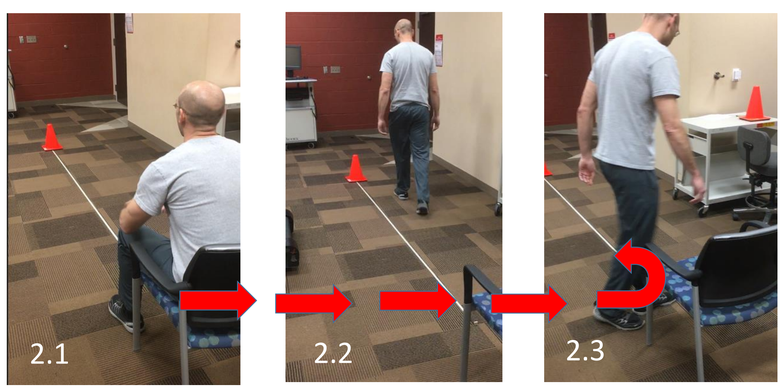


Figure 2. The **TUG** measures mobility and fall risks by having the individual rise from a chair, walk out and back three meters, then sit back down; >12.5 seconds is generally considered abnormal mobility.



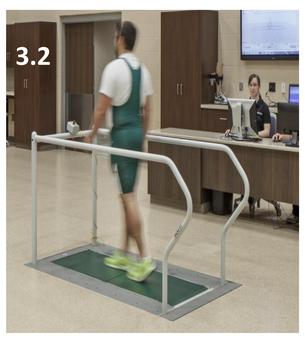


Figure 3. Subjects walked on treadmill for six minutes at self-selected speed, while wearing 30 retro-reflective markers. Data was captured on a twelve camera 3-D motion capture system.

- **FAB** is a series of ten balance tests to assess the subject's ability to use their somatosensory cues to maintain upright balance in varying situations.
- **mFES** is a subject questionnaire that pertains to their fear of falling while completing daily tasks and scores less than eight are indicative of a fear of falling.
- **ABC** Scale is a confidence-based questionnaire pertaining to confidence in completing normal daily activities without falling; a mean of less than 67% indicates a risk of falling.

RESULTS

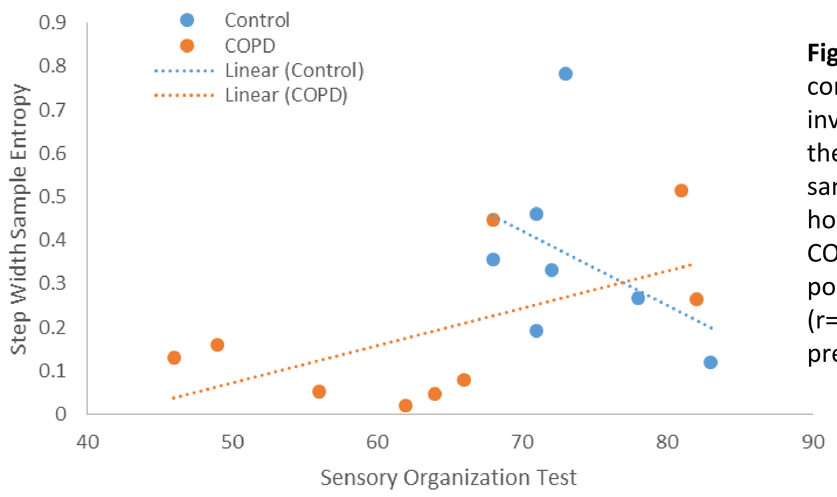
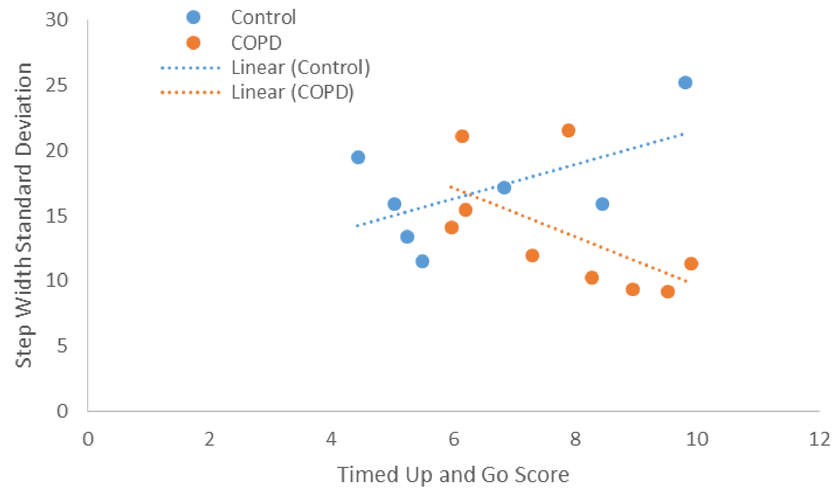


Figure 4. The healthy controls showed a moderate inverse relationship between the SOT and step width sample entropy (r=-0.40) however, the patients with COPD demonstrated a strong positive relationship (r=0.59). Higher SOT score is preferred.

Figure 5. A strong relationship between the TUG and step width standard deviation was found for both controls and patients with COPD, however the relationship was inversed between the groups (control r=0.59, & COPD r=-0.59). Lower TUG score is preferred.



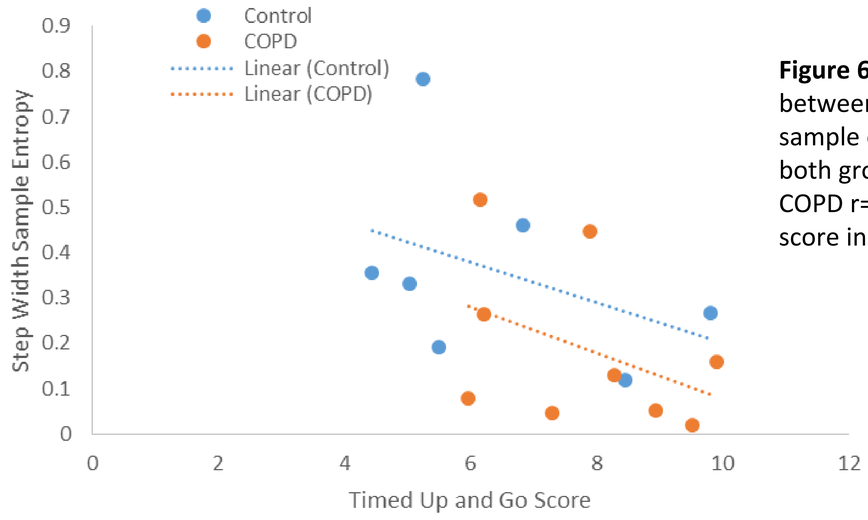


Figure 6. A moderate relationship between the TUG and step width sample entropy was found for both groups (control r=-0.41, COPD r=-0.41). A higher TUG score indicates fall risk.

DISCUSSION

- We hypothesized that functional balance tests will more closely correlate to the step width data as compared to subjective balance questionnaires and this was confirmed. No relationship was found between step width variability and the subjective questionnaires.
- Based on the close relationship between step width sample entropy and the TUG, further research into whether step width sample entropy calculation is the best indicator for balance deficits while using a dynamic balance measure is recommended. Since a higher TUG score indicates an increased fall risk, a lower sample entropy could have a similar meaning.
- The inverse relationships found for the SOT & step width sample entropy and the TUG & step width standard deviation could be indicative of differential behaviors between the two groups.

REFERENCES

1. Saey D, et al. (2003) American Journal Respiratory Critical Care Medicine, 168:425-430.
2. Watz H, et al. (2009) European Respiratory Journal, 33:262-272.
3. Roig M, et al. (2009) Respiratory Medicine, 103:1257-1269.
4. Smith M, et al. (2010) Gait & Posture, 31(4):456-60.
5. Owings T, et al. (2004) Gait and Posture, 20(1), 26-29.
6. Butcher S, et al (2004) Journal of Cardiopulmonary Rehab. and Prevention, 24(4), 274-280

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